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ABSTRACT

This paper presents the final project summary for a National Science Foundation (NSF) science education project for developing science career interests in Mexican-American elementary students, conducted at Texas A&I University, and completed in December 1976. The program emphasized long range results with a model which could continue to encourage minority members to enter science careers even after outside funding ceases. Elementary science teachers were given summer workshop training for increasing student interest in science. During the following school year, an evaluation of student science interest among classes of teachers attending the workshops and those not attending the workshops indicated there were no significant differences between gains made by either group. Reasons for the lack of gains are described. (SL)

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DEVELOPING SCIENCE CAREER INTERESTS IN BILINGUAL, MEXICAN-AMERICAN ELEMENTARY STUDENTS

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National Science Foundation

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INTRODUCTION

There have been many programs aimed at increasing the number of minority group members in science and technological careers in the past decade. Most of these programs have been directed toward the training of high school and/or college minority students in the basic sciences, math, and technical areas. Recently some more programs have been directed toward changing the stereotyped image of those who are scientists, engineers, etc., and encouraging them (minority students) to enter training for those professions. However successful these recruiting and training programs may be, they are only stop-gap measures and fail to provide for a continual steady stream entry into science careers.

The long range problem then results, becoming one of developing a model whereby after outside funding ceases a structure has been created that can, for years to come, continue to encourage minority members to enter careers in science. Another associated problem is that when minority youth are recruited during the last years of high school or during college, many have to go back and take prerequisite course work, which simply delays and discourages entry into science careers. Therefore, the best approach would be a long range approach, designed to encourage and develop positive attitudes toward science and science careers at an early age - at the elementary school level. This would then permit minorities to take advantage of the science and math course work and counselling already available in the secondary schools.

In the South Texas area, a majority of the public school students are bilingual, Mexican-Americans, with English being primarily the second language for many of these students. This poses a difficult problem for the

average elementary school teacher who typically has had no formal training in bilingual teaching strategies.

The purpose of the experimental project was to develop the following traits in teachers of bilingual, Mexican-American elementary students:

1. A solid science foundation
2. Skills and strategies needed to effectively reach and teach the bilingual student, who speaks Spanish as a first language
3. An awareness of job opportunities in science in general, and more specifically, of job opportunities in science within the geographical area in which their students live
4. Skills necessary in counselling and guiding the Mexican-American student toward future course work and careers in science

It was hypothesized that if elementary students had teachers who possessed the above mentioned traits they in turn could:

1. Develop confidence to do well in science
2. Develop a desire to learn more science
3. Have knowledge of career opportunities and employment trends in science and science related fields

METHODOLOGY

The project was designed in five interrelated phases.

Phase I - Teacher Training

A summer workshop of three weeks was held for 18 teachers of upper-elementary (grades 5 & 6) bilingual, Mexican-American students. The workshop took place from 9 a.m. to 4 p.m. everyday. Participants were selected from a wide geographical area of approximately a 140 mile radius from Texas A & I - Kingsville campus. Ten of the 18 teachers were bilingual, the remaining 8 spoke only English. The average Mexican-American student population in the public school classes of the workshop participants was 66

percent. Participants could enroll for six graduate credits in Education: Education 446-Workshop for Teachers of Elementary School Science and Education 518-Advanced Teaching Skills. Participants received a stipend from the National Science Foundation for their participation.

The workshop emphasized (1) an understanding of the different needs of a bilingual student and some of the dimensions of the bicultural world in South Texas. (2) The development of science instructional materials for upper-elementary bilingual students. These were mainly slide-tape presentations done in both English and Spanish. (3) A knowledge of science careers and science career training, trends, etc.

To have the participants learn firsthand about salary, training and employment trend information, field trips were utilized to have teachers visit with engineers and scientists at their place of employment. This gave them a chance to get a feel of the worklife, attitudes, etc. of some of the people in science related occupations. Participants visited the following sites: P. P. & G. Industries, Suntide Refinery, Aransas National Wildlife Refuge, Brooks Aerospace Medical Center, Kingsville Naval Air Station, Cunningham Water Filtration and Treatment Plant, Corpus Christi International Airport, and National Weather Bureau. With the assistance of Dr. Paul Bryant, the Co-Director of the Project and Head of the Texas A & I University Counselling Certification Program, participants developed extensive science career information files to be used with and by their elementary students. Participants worked the entire year developing and expanding these useful files.

While on campus, bilingual teaching strategies were being developed through the assistance of Dr. Salvador Alvarez and Mr. Manual Salinas. The University photographer, Mr. Bob Allen, assisted the participants in photographic techniques to help them create bilingual slide-tape presentations based

on mutually agreed upon elementary science units. These slide-tape presentations were then shared by the participants, during the regular school year, for their classroom utilization.

Phase II - Pre-Testing

In early October 1975, a control group of teachers was identified, and if possible, were within the same school plants as were the workshop participants. This was done in order to reduce the vast amount of traveling time required to visit the schools and administer the pre- and post-tests, communicate with teachers, etc. Both control and experimental teachers' classes were pre-tested. The tests consisted of a science achievement test (developed by the Project Director from a standardized test and from a large population of sample test questions prepared by project participants during the Summer Workshop - See Appendix A) and a career attitude instrument. The fifth grade students received the SRA "What I Like to Do" inventory and the sixth grade students received the SRA "Kuder Form E - General Interest Inventory". The testing required two days and was administered to students during the regular school day. Testing was administered under the direction of the Project Director, Dr. Robert Warren with much assistance from several students enrolled in the bilingual education doctoral program at Texas A & I University.

Phase III - Inservice Training

Participants returned to campus for 15 three hour Saturday sessions, scheduled about every three weeks from September through May. Each session featured a speaker representing one of the specific academic areas traditionally associated with science and engineering (i.e. Math, Biology, Chemistry). The speakers, all Texas A & I University faculty members, presented the participants with "hands on" type experiments in their particular academic fields that could be readily used in the elementary classroom. These sessions were

not lecture oriented, but were workshops where participants could interact and work with the "hands on" experiments firsthand.

Another regular feature of these Saturday meetings was the sharing session. Participants would share what unique things they had done with their science classes during the past three weeks. This was considered by many to be the highlight of each meeting and provided a great many practical, classroom tried, simple science instructional strategies, gimicks, bilingual teaching ideas, etc. for others to use.

Phase IV - Post-Testing

In late March, 1976, alternate forms of the Science Achievement test and the same test forms of the attitude inventories were administered to both the control and experimental students as a post-test.

RESULTS

Statistical Analysis

General Achievement Test Scores

A simple "t" test was used to compare:

a. pre-test scores of the experimental and control groups

b. post-test scores of the experimental and control groups

c. growth scores (pre-test score minus post-test score) of the experimental and control groups

The results of all three "t" tests indicate no significant difference between the experimental and control groups as a result of the project.

Career Interest Inventories

For both career interest inventories (Fifth Grade - "What I Like To Do" and Sixth Grade - Kuder Form E - General Interest Inventory) a simple "t" test was used to compare:

a. pre-test score of experimental and control groups

b. post-test scores of experimental and control groups

c. growth scores (pre-test score minus the post-test score) of the experimental and control groups.

The results of each of these "t" tests indicate no significant difference between the control and experimental groups as a result of the project.

Science Grades

It was impossible to assess changes in the science grades of the experimental and control group students because of unforeseen difficulties in obtaining these grades. First, time limitations imposed by the N.S.F. grant ending before the area public school finished school and completed the recording of grades, and secondly, a fairly large number of migrant students in several of the school districts made tracing previous science grades a prohibitive task.

Although not a part of the original research design, the experimenters, attempting to seek some more understanding into what statistically seemed a failure, did further statistical computation. Such factors as sex and ethnic background were compared to test growth scores, etc., but even these further explorations proved not to yield significant differences as a result of the project.

Non-Statistical Analysis

Informal surveying of the workshop participants indicated that they had placed much more time and much greater emphasis on science and science career instruction than they had previously. They indicated a utilization of field trips, bilingual slide-tape programs, demonstrations, etc. that were a direct result of workshop participation.

DISCUSSION OF THE RESULTS

Statistical analysis indicated that there were no significant differences between gains made by control and experimental groups for any of the measured variables. Although this is very disturbing, expecially tc the project staff and participants who were convinced that the program had been a huge success, a careful subjective analysis of other intervening variables associated with the program indicate quite a bit of success.

The main reason for the lack of any detectable significant gains in test scores can be judged as a result of the invalidity of the testing instruments. For example, of the 453 students in the sixth grade who took the Kuder Form E - General Interest Inventory, only 129 (28 percent) yielded scores with enough internal validity to be used for statistical analysis. When 72 percent of the testing population yields invalid scores, it negates utilizing the remaining 28 percent of the scores for any sort of statistical inference. Several reasons seem apparent for this testing dilemma. First, and foremost, teachers of both the experimental and control group students, as well as the university testing consultants who administered the instruments, indicated the frustration that so many of the students seemed to have in the reading and subsequent understanding of the interest inventories and science achievement tests. Characteristically, South Texas schools fall way below National norms on reading achievement, which is due in a great part to the many problems associated with the bilingual student. Totally 66 percent of the tested population was bilingual. This tends to explain the overwhelming difficulty with the testing and the resultant plethora of invalid test scores.

Another confounding problem was that of polution of the control group by the experimental group. Because of the relative smallness of local schools

and the professional closeness of teachers, many of the control group classes ended up copying and/or sharing in the science and science career instructional activities of the experimental classes. Field trips were taken together, bilingual slide-tape presentations were shared, etc. thus causing an equalization of the instructional process and negating differences which might have resulted as a result of the project.

Control and experimental teachers alike admitted feeling a stake in the program and had worked harder and linger to improve their science instruction. There is no real way to quantize this resultant "Hawthorne Effect" except to verify that it probably did play another larger factor in not being able to detect significant differences in the growth of the experimental and control groups.

CONCLUSIONS

"The operation was a success, but the patient died". By the judgment of all those involved, the project increased teacher interest in science and science career education. It increased the science and science career teaching skills of participating teachers. It increased the awareness of participating teachers to the different needs of the bilingual science student in his bicultural environment and gave them increased instructional and counselling skills to teach science to bilingual students. These judgments of success were obtained through frank discussion with participating teachers, principals, students, and most of all, other teachers who were the circumstantial beneficiaries of the entire project. Herein lies one of the two major reasons for the inability to obtain significant statistical differences in growth scores. The other reason is that there are presently no standardized instruments which will validly measure attitudes towards science, and science achievement for bilingual, bicultural students, who in

addition to language barriers, are poor readers. This project can be considered useful as a model for other similar projects, once better test instruments are available.

NSF SCIENCE ACHIEVEMENT TEST

FORM A

1. We cannot see stars in the daytime without a telescope because:

   a. the sunlight is so bright
   b. they stop shining
   c. they go away
   d. the moon is in front of them.

2. Which one of these is the surest way to find out if it may rain?

   a. Ask someone who says his foot hurts just before a rain
   b. Ask almost any grownup
   c. Ask any teacher
   d. Look at the weather report in the newspaper

3. A cloud is most like-

   a. dew
   b. snow
   c. fog
   d. rain

4. Which of these is not burned for fuel?

   a. wood
   b. paper
   c. stone
   d. coal

5. We test new ideas to see if they are true or not true by-

   a. asking questions
   b. writing letters
   c. experimenting
   d. making guesses

6. Houseflies cause disease because they-

   a. make many germs inside their stomachs
   b. carry germs on their bodies
   c. sting with a poison
   d. eat spoiled meat

7. After eating dinner, a boy's most healthful choice would be to-

   a. take a fast walk
   b. ride his bicycle
   c. play a game like basketball
   d. work on his model airplane

8. Plants growing on the side of a hill are able to keep soil from washing away because they-

   a. have roots to hold the soil
   b. use up water slowly
   c. give shade
   d. make soil very hard

9. Men have learned much about animals and plants of long ago by studying-

   a. weather
   b. fossils
   c. tides
   d. planets

10. The best choice for a material that is light and strong would be-

   a. aluminum
   b. bronze
   c. slate
   d. lead

11. Near which plant might you find a road runner, horned toad, and sidewinder rattlesnake?

   a. cactus
   b. pine tree
   c. lily pad
   d. seaweed

12. It takes one day of 24 hours for the-

   a. moon to go once around the earth
   b. earth to make one full turn on its axis
   c. earth to go once around the sun
   d. sun to go once around the earth

13. Which one of these is unlike the other three in an important way?

   a. bird
   b. fish
   c. rock
   d. tree

14. Friction may wear out shoes, but it is most useful in-

   a. keeping an airplane in the air
   b. stopping a bicycle quickly
   c. stopping water from boiling
   d. putting out a fire

15. An eclipse of the sun happens only when the

a. earth is between the sun and moon
b. moon is between the sun and earth
c. sun is between the earth and moon
d. sun is lower on the horizon

16. The smallest unit of life is

a. an egg
b. an organ
c. a pupa
d. a cell

17. Reptiles are:

a. slimy
b. cold blooded
c. warm blooded
d. invertebrates

18. The part of the plant that produces seeds is the:

a. leaves
b. stems
c. flower
d. root hairs

19. The hammer, anvil, and stirrup are parts of the:

a. outer ear
b. inner ear
c. middle ear
d. none of the above

20. Blood with the most oxygen will be found in blood vessels-

a. in the intestine
b. going to the lungs
c. in the legs
d. leaving the lungs

21. The fluid in the semicircular canals helps you keep your:

a. hearing
b. balance
c. appetite
d. none of the above

22. The earth revolves around the sun

a. once a day
b. once a month
c. once a year
d. four times a year

23. The pull of gravitation on the moon is about

a. the same as that of the earth
b. ½ of that of the earth
c. 1/6 of that of the earth
d. None of the above

24. The outermost layer of the atmosphere is

a. the stratosphere
b. the troposphere
c. the ionosphere
d. the exosphere

25. A canyon in an ocean basin is called a:

a. trench
b. valley
c. ravine
d. ditch

26. The atmosphere is made up of

a. 21% oxygen and 78% nitrogen
b. 78% oxygen and 21% nitrogen
c. 2% oxygen and 78% nitrogen
d. 100% oxygen

27. The smallest particle of matter that is identifiable as an element is:

a. an electron
b. an atom
c. a nucleus
d. a proton

28. A good example of a conductor of electricity would be:

a. paper
b. cotton
c. wood
d. copper

29. The ability to move something by pushing or pulling is

a. inertia
b. mass
c. energy
d. radiation

30. For ease in lifting a load with a lever, place a fulcrum

a. in a soft area
b. far from the load
c. near the load
d. none of the above

NSF SCIENCE ACHIEVEMENT TEST

FORM B

1. The earth is heated mostly by the-

   a. clouds
   b. moon
   c. other planets
   d. sun

2. Air presses on things all around us because of the-

   a. sun's pull
   b. moons pull
   c. earth's gravity
   d. earth's magnetism

3. Weather forecasts are made in many different places in the United States because-

   a. each state wants its own weather bureau
   b. the weather is sure to change much from day to day
   c. the weather bureau wants to be sure its forecast is right
   d. the weather is different in different parts of the United States

4. From his home, a boy walks straight south to school. To come home most quickly, he should walk-

   a. west
   b. north
   c. south
   d. east

5. Which one of these is wrong to do if your clothes catch fire?

   a. roll on the floor
   b. put water on the clothes
   c. wrap a blanket around yourself
   d. run as fast as you can

6. If a person wants to keep birds around his land, he should-

   a. plant many trees and shrubs
   b. buy several good bird whistles
   c. make some bird nests
   d. build tall fences

7. How do the amounts of land and water on the earth's surface compare? There is-

   a. much more land than water
   b. a little more water than land
   c. much more water than land
   d. a little more land than water

8. A killing jar, spreading board, and net are equipment needed for a collection of-

   a. fish
   b. snakes
   c. insects
   d. birds

9. A good way to keep a green plant from making food is to-

   a. keep it from sunlight
   b. wash its leaves
   c. put plants in rows
   d. plant it alone in a flower pot

10. How is a toad kept safe by nature?

   a. He has sharp teeth for fighting
   b. He is poisonous
   c. He moves fast from place to place
   d. He is colored like the ground

11. Which of these signs would be best to place near water that is unfit to drink?

   a. Filtered Water
   b. Mineral Water
   c. Polluted Water
   d. Distilled Water

12. Where trees and plants grow very close together, they are often very tall and thin because they need more -

   a. water
   b. air
   c. minerals
   d. sunlight

13. Wading birds would have little use for-

   a. long legs
   b. strong, sharp claws
   c. long, pointed bills
   d. long necks

14. When plant life has been in the earth under heat and great pressure for millions of years, which one of these has been made?

   a. coal
   b. iron
   c. aluminum
   d. copper

15. In a land where there is much snow, many animals have white coats. This is helpful to them because the

    a. white color protects animals from strong sunlight
    b. white color takes in the heat of the sun
    c. white color makes animals attractive to other animals
    d. darker-colored animals are easily seen

16. The process in which a green plant makes its own food is called

    a. mitosis
    b. photosynthesis
    c. cellulose
    d. None of these

17. Grass will not grow in a thick forest for the main reason that

    a. the soil is too rocky
    b. it cannot get enough light
    c. the soil is too wet
    d. none of these

18. The organ that is not found in the digestive system is

    a. lungs
    b. stomach
    c. large intestine
    d. small intestine

19. Animals that have a covering of hair and that produce milk to feed their young are:

    a. mammals
    b. reptiles
    c. insects
    d. amphibians

20. Blood is carried back to the heart in blood vessels called

    a. arteries
    b. capillaries
    c. veins
    d. intestines

21. The star that provides the earth with both heat and light is

    a. the North Star
    b. the sun
    c. Jupiter
    d. none of the above

22. A group of stars forming a pattern in the sky is a:

a. constellation
b. galaxy
c. universe
d. nebula

23. An astronaut on the moon finds that he has changed in

a. mass
b. weight
c. shape
d. height

24. When it is summer in the northern hemisphere, the southern hemisphere is having

a. summer
b. winter
c. autumn
d. spring

25. Clouds are formed by the process of

a. condensation
b. precipitation
c. rotation
d. evaporation

26. Smog is the pollution of

a. water
b. air
c. land
d. minerals

27. The forms of matter are

a. solid and liquid
b. liquid and gas
c. solid and gas
d. solid and liquid and gas

28. A dry cell battery generates electrical energy from:

a. moving magnetic fields
b. chemical action
c. friction
d. none of these

29. A plastic comb rubbed with wool attracts bits of paper because it is:

a. magnetized
b. charged with electrons
c. filled with teeth
d. elongated

30. Radio waves travel

a. at the speed of light
b. as fast as sound waves
c. slower than sound waves
d. none of the above

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